

AMENDMENTS TO THE DRAWINGS

Figures 3, 4, 5, and 6 have been labeled as Prior Art

Attachment: Replacement Sheet(s)

REMARKS

Claims 1 and 2, all the claims pending in the application, are rejected. Claim 1 is amended and claim 2 is cancelled. New claims 3-14 are added.

Priority

The instant application is a national stage (371) entry of PCT/JPO4/11712 having an international filing date of 8/9/04, which further claims foreign priority to JP 2003-293835 filed 8/15/03.

The Examiner states that “Applicant cannot rely upon the foreign priority papers to overcome any rejection in this Office action, because a translation of said foreign priority papers has not been made of record in accordance with 37 CFR 1.55. See MPEP § 201.15.”

Applicants agree that reliance on the priority date of JP 2003-293835 would require submission of an English language translation. However, as to the PCT priority date, Applicants’ rights are already established under the provisions of the Patent Cooperation Treaty and U.S. Law. Moreover, the present application is necessarily a faithful translation of the Japanese PCT application, as a national stage entry.

Thus, on the present record, the present application is entitled to at least a priority date of August 9, 2004. Applicants reserve the right to submit a verified translation of the Japanese priority document in order to perfect a claim to a priority date of August 15, 2003.

Information Disclosure Statement

The Examiner takes the position that the IDS submission by the Applicant at the time the present application was filed on February 10, 2006 was not proper because copies of the listed items were not provided. Those items all were identified in the International Search Report prepared during the international stage for the parent of the present national stage application. The Examiner also states that the ISR is not a proper IDS.

First, Applicants submitted the IDS on the assumption that the International Bureau would be providing the cited documents along with the international application. This assumption was expressly stated in paragraph 2 of the IDS as submitted on February 10, 2006. Is

this assumption not correct and does the Examiner not have access to the international file?

Second, Applicants note that the Examiner struck out the listing of the references on Applicants' submitted form 1449 and inserted the note "only as listed in English on ISR 11/16/04." Does this mean that the Examiner does not obtain and review any foreign language documents?

Third, even if Applicants did not have a correct assumption as to the Examiner's access to the international search results, is it the Examiner's practice not to consider the art identified in the International Search as being the most pertinent? Such practice does not appear to be consistent with compact prosecution and clearly leads to the increased backlog problem currently faced by the USPTO.

Finally, than dispute the propriety of the Examiner's approach to giving no consideration of the work product of other Offices in this case, Applicants are submitting the cited references in a new IDS concurrently filed with the present Amendment.

Nonetheless, it would be helpful to Applicants to have answers to these questions as Applicants do not wish to burden the Examiner with unnecessary prior art submissions or to incur costs unnecessarily.

Drawings

The Examiner states that "Figures 3, 4, 5, and 6 must each be designated by a legend such as --Prior Art--, because only that which is old is illustrated in these drawings (each of these drawings is indicated as being "conventional" in the corresponding brief description(s) thereof found in the specification at page 6 line 22 to page 7 line 3, abbreviated as p6/L22 to p7/L3, and in further detail at p1/L11 to p4/L25)."

Appropriately revised replacement sheets of drawings are being submitted.

Specification

The Examiner objects to the disclosure because of several typographical or grammatical errors. Appropriate correction has been made.

Claim Rejections - 35 USC § 103

Claims 1-2 are rejected under 35 U.S.C. 103(a) as being unpatentable over either

Yasuzato et al. (US 6,004,699) or Applicant's Admitted Prior Art (AAPA) and either Ito et al. (US 6,030,729) or Kim (US 6,576,374). This rejection is traversed for at least the following reasons.

Amended Claim 1

Claim 1, as now amended, is focused on a three-process method of manufacturing a phase shift mask having, on a transparent substrate, a *main opening* formed by partly removing a light-shielding film and an *auxiliary opening* provided at a peripheral portion of the main opening. Importantly, the *auxiliary opening* has a width incapable of being resolved when transferring.

Auxiliary Pattern Below Resolution Limit

The claim now expressly defines the method as producing an auxiliary pattern that has a fine pattern below the resolution limit. That is, the amended claim expressly addresses the difficulty in achieving a pattern forming accuracy when the auxiliary pattern having a line width finer than the resolution limit is used.

Detailed Three Process Method

The method is defined according to three processes, a first process involving the deposition of several films, including a light shielding film, a thin film and a first resist film, on a transparent substrate. In the first process, the light-shielding film is further detailed as comprising “a material being etchable by a fluorine-based etching medium,” and the thin film has a resistance to the fluorine-based etching medium, and is further detailed as comprising “a metal selected from chromium, tantalum, titanium, aluminum, hafnium, vanadium, or zirconium, an alloy of one or more of said metals, a metal compound containing one or more of oxygen, nitrogen, carbon, fluorine along with one of said metal or alloy.” The first process further includes exposing a pattern corresponding to the main opening and the auxiliary opening onto the first resist film, followed by developing, etching and stripping steps.

In the second process, a second resist film is formed on the transparent substrate, and a pattern is exposed corresponding to one of the main opening and the auxiliary opening, followed by developing a second resist pattern and etching part of the transparent substrate to a depth such

that the phases of the light passing through the main opening and the light passing through the auxiliary opening differ from each other by a predetermined angle.

In the third process, a part or all of the etching mask layer is removed.

The Examiner summarizes the teachings of each of Yasuzato et al, the APAA, Ito et al and Kim and asserts that the it would be obvious to apply a hard mask disclosed in Ito et al or Kim to a phase shift mask (PSM) having auxiliary patterns disclosed in Yasuzato et al or the APAA. This position is not correct, as demonstrated subsequently.

Yasuzato et al

Yasuzato et al discloses a photomask having a main pattern as openings formed on a light shielding film, and auxiliary patterns surrounding the main pattern. According to Yasuzato et al, in a conventional photomask having an auxiliary pattern, a fine pattern below the limit of resolution is required. Yasuzato recognizes that such requirement makes fabrication of a mask quite difficult because the auxiliary pattern may be smaller in size than the limit at which a pattern can stably be formed by a pattern drawing apparatus. Yasuzato recognizes that , if a size of the auxiliary pattern is increased, the auxiliary pattern itself is transferred.

Yasuzato Requires Same Size Patterns

In order to solve the above-mentioned problem, Yasuzato et al discloses a technique that ***requires*** the auxiliary pattern to be substantially the same size as the main pattern. The substrate in the auxiliary pattern region is etched to a depth at which a phase difference, equal to an integral multiple of 360 degrees, is produced between light transmitted through the main pattern and light transmitted through the auxiliary pattern. This structure is advantageous in improving the depth of focus by using the off-axis illumination method when pattern transfer is performed by using the photomask. However, although the auxiliary pattern is large in size and, therefore, is likely to be transferred, the side wall effect of the etching step portion of the process prevents the auxiliary pattern from being fully transferred.

In summary, it is an object as well as an effect of Yasuzato et al to improve the depth of focus and to facilitate the fabrication of the photomask by forming, as the auxiliary pattern surrounding the main pattern, a pattern equivalent in size to the main pattern. Thus, as a

fundamental principle of Yasuzato et al, a pattern having a size smaller than the resolution limit would not be formed.

Yasuzato Does Not Teach a Hard Mask Layer

As properly pointed out by the Examiner, Yasuzato et al does not teach an etching mask layer (or a hard mask layer). Thus, this is a second distinction from the claimed invention.

Yasuzato Does Not Use Auxiliary Pattern For Phase Shift

As previously noted, amended claim 1 addresses the difficulty in achieving the pattern forming accuracy when the auxiliary pattern having a line width finer than the resolution limit is used. The present invention is focused on solving this problem so that the auxiliary pattern can be used for a phase shift in the second process.

On the other hand, Yasuzato et al aims to achieve a necessary phase shift effect without using an auxiliary pattern having such a fine line width (therefore, by avoiding the difficulty in fabrication).

Yasuzato and Claimed Invention are Fundamentally Different

In view of the foregoing, it is clear that, as a fundamental principle, Yasuzato et al adopts an approach to achieving phase shift that is diametrically opposite to that of the present invention in order to improve the performance of pattern transfer by using the photomask.

Yasuzato Teaches Away From the Claimed Invention

A person skilled in the art who refers to Yasuzato et al would be motivated to manufacture a photomask fundamentally different from a mask resulting from the present invention, i.e., a photomask which does not have an auxiliary pattern having a fine line width below the resolution limit. Therefore, Yasuzato et al teaches away from this invention.

Even if the auxiliary pattern in Yasuzato et al is combined with other references (Ito et al, Kim), it is impossible to constitute the photomask of this invention having a fine pattern below the resolution limit.

Ito et al

Ito et al discloses a process that addresses a problem concerning a fall in depth of focus, because of a phase of light penetrating a light shielding film having a non-zero transmittance. Specifically, Ito et al describes that the light passing through the light shielding film provides a phase difference of $(2m-1)\pi$ relative to the light passing through a medium, such as air, that is the same in thickness as the light shielding film.

Carbon Layers Are Not Claimed Etching Mask

In framing the rejection and describing the relevance of Ito et al, the Examiner refers to Figs. 8A to 8E of the patent. Those figure relate to a method of manufacturing a photomask by using a carbon layer 703. According to Ito et al, the carbon layer protects the light shielding film during etching of the quartz substrate so that no decrease in thickness of the light shielding film occurs. Therefore, the phase of the light shielding film is maintained. Apparently, the Examiner judges that the carbon layer in Ito et al corresponds to the etching mask layer of the presently claimed invention.

However, the photomask in Ito et al is significantly different from this invention set forth in the amended claims. First, the carbon layer 703 in Ito et al is made only of carbon and does not contain the following materials now specified by amended claim 1:

"a metal selected from as chromium, tantalum, titanium, aluminum, hafnium, vanadium, or zirconium, an alloy of one or more of said metals, a metal compound containing one of more of oxygen, nitrogen, carbon, fluorine along with one of said metal or alloy."

Carbon Layer Has Different Characteristics and Purposes

Even if the carbon layer in Ito et al has some effect of preventing the decrease in thickness of the light shielding film during etching of the quartz substrate, the carbon layer is significantly different from the etching mask layer in this invention in the following respects.

(1) The carbon film 703 disclosed in Ito et al is damaged during removal of the resist pattern after the first process. As a resist removing method, a method using (1) a sulfuric acid or an organic solvent and (2) an ashing method using oxygen or ozone water are generally known. In the method (1), a residual chemical agent induces foreign substances generated on the surface

of the pattern. In this regard, the latter method is superior. However, in the method (2), the carbon film itself is substantially damaged (or extinguished).

On the other hand, the material of the etching mask layer defined in this invention is free from the above-mentioned problems.

(2) In Ito et al, the carbon film is used for the purpose of protecting the light shielding film so that the light shielding film is not decreased in thickness during etching of the quartz substrate. However, during etching of a quartz substrate (for example, in case where a fluorine-based etchant is used), the damage to the carbon film itself formed by a coating process is notable (although Ito et al does not describe the film property of the carbon film, it is unlikely that the carbon film 703 formed by coating has a strong crystal structure).

Applicants respectfully submit that one skilled in the art would understand that, during etching of the quartz substrate, there will be a decrease in thickness of the light shielding film if the etching mask layer (the carbon film in Ito et al) does not remain to the end of etching. The metal-containing etching mask layer defined in amended claim 1 is highly resistant against the above-mentioned etching.

(3) The metal-containing etching mask layer defined in amended claim 1 has a degree of freedom in that, depending on the purpose of use, the etching mask layer may be partly left on the mask so as to provide another function (page 12, lines 11-12 of the present specification). In order to achieve such additional function of the etching mask, it is of great significance that the etching mask layer is made of a metal-containing material defined in this invention, not a chemically-instable material, such as carbon. Taking into the chemical instability of carbon into consideration, the carbon film disclosed in Ito et al can not be left on the mask to be used again. Thus, the carbon film in Ito et al only withstands the use as a temporary etching mask.

For example, the etching mask layer being left on the photomask as a finished product has the following advantage.

In case where the light shielding film is a light semi-transmitting film, the etching mask layer in a non-transfer part is left so as to exhibit a novel function of completely shield exposure light in a desired part during use of the photomask. Specifically, the etching mask layer is left in

a non-transfer area of the photomask to provide the above-mentioned light shielding function. In this manner, in the non-transfer area, unnecessary exposure light does not reach an object of transfer. For example, if an aperture of an exposure apparatus (stepper) is wider than a transfer area of the photomask, complete light shieldability is assured in the non-transfer area at the outer periphery of the photomask.

In the presently claimed invention, the material of the etching mask layer is limited as set forth in the amended claims so as to assure a great merit in function and effect, which is not conceivable from the description of Ito et al.

Kim

Kim describes the problem that occurs when preparing an alternating phase shift mask. Specifically, during the step of patterning a chromium film on a transparent substrate and during the step of forming a groove on the transparent substrate, unnecessary substances are produced to adversely affect the incidence and the phase of light. In order to solve the above-mentioned problem, Kim uses a mask blank having a protective film formed on the surface of the light shielding film.

Kim Focuses On Preventing Formation of Unnecessary Substances During Etching

In particular, Kim aims to prevent, in the step of forming the groove in the transparent substrate by etching (second process in this invention), unnecessary substances from being formed as a result of reaction between the etchant and the exposed edge portion of the light shielding film and from being deposited in the groove. Accordingly, in Kim, the protective film formed on the light shielding film is common in etching property to the transparent substrate (i.e., the protective film is made of a material etchable by a fluorine-based etchant). When the formation of the groove is terminated, the exposed edge portion of the protective film is extinguished.

Kim's Film Cannot Be Removed

The protective film in Kim is left on the mask, except the above-mentioned edge portion, and can not be removed. This is because, if the protective film is removed, the transparent substrate is etched and removed as well, since the protective film is common in etching property

to the transparent substrate. As a result, the photomask of Kim is used in the state where the protective film, whose function has already ended, is left on the transfer pattern of the photomask.

Retained Film is Undesirable

As readily appreciated by those skilled in the art, retention of a film is not favorable during use of the photomask. First, if the light shielding pattern is increased in thickness, the wall surface of the pattern is enlarged. Therefore, the transfer accuracy (transfer fidelity) by exposure light is decreased.

Further, when the protective film of Kim is left on the light shielding film, except the above-mentioned edge portion, the optical characteristic (for example, reflection characteristic) in that part is different from the optical characteristics of other parts. As a consequence, pattern inspection using reflection light can not be carried out. It is difficult to identify the defects by using the variation in reflection light.

Invention Etching Mask is Selectably Removable

By contrast, the etching mask layer in the presently claimed invention can be removed completely in a part where the transfer pattern is formed, without causing the above-mentioned disadvantage. This feature is of a great significance for actual users of photomasks and is an advantage of the invention.

In this invention, it is also possible to partly leave only a desired part (for example, in a non-transfer region) of the etching mask layer as described above.

The above-mentioned advantages of the invention can be obtained by selecting film materials (of the light shielding film and the etching mask layer) as specified in amended claim 1. This structure of this invention is neither disclosed nor suggested in any one of the cited references and can not be achieved even in combination of the cited references. Furthermore, the above-mentioned advantageous effect of this invention can not be envisaged from any one of the above-mentioned references or even in a combination thereof.

APAA

The teachings that the Examiner refers to as APAA are derived from JP A 07-20625 and are described with respect to Figs. 4 and 5 in alternative approaches to producing main openings 22 and auxiliary openings 23 in a light shielding film 21 that is disposed on a transparent substrate 20. The process in Fig. 4 concurrently produces the main and auxiliary openings in the thin film 21. The process is described as resulting in “openings so close to each other” that it is difficult to write both the main opening 22 and the auxiliary openings 23 on the same resist film by electron beam writing. The main opening is extended into the substrate using a second resist and etching the main hole deeper.

Problems with APAA

This approach causes the light shielding film be damaged, as illustrated in Fig. 6. Moreover, as is referred to in the specification, a similar process is described in JP H7-20625, however, as an inferior embodiment. This is because closely located exposing areas could cause electron beam scattering that mutually interfere, which decrease the patterning precision. In addition, since this process requires exposing the resist film placed directly on the substrate (i.e., non-conductive material), charging-up phenomenon could occur and harm the resist film patterning.

For the foregoing reasons, it is highly likely that the person or ordinary skill who reads the part of the present description and the cited reference H7-20625 be encouraged to select this approach.

The process in Fig. 5 offers an improvement to Fig. 4 by having the openings sequentially produced, where the main opening is made first using a first resist that later is totally stripped. The auxiliary openings are subsequently produced by applying a second resist that protects the main opening and permits patterning so that the auxiliary holes can be made. The second resist is then completely stripped, leaving the patterned substrate 20 and film 21. The deficiencies of this approach lie in the difficulty in accurately overlying the resists and patterns.

However, there is no teaching or suggestion in the APAA of any process that permits an auxiliary opening having a width incapable of being resolved when transferring, as now set forth in claim 1. Further, there is no teaching or suggestion with respect to the limitations on the light

shielding film or the thin film, as now expressed in amended claim 1. Finally, there is no teaching or suggestion of using an etching mask layer.

With regard to the teachings in Ito et al and Kim, the same analysis as provided above for the combination with Yasuzato would apply.

For all of the foregoing reasons, the claims would be patentable over the references taken alone or in combination.

Claims 1-2 are rejected under 35 U.S.C. 103(a) as being obvious over Okubo et al. (US 7,314,690) in combination with either Yasuzato et al. (US 6,004,699) or Applicant's Admitted Prior Art (AAPA) and either Ito et al. (US 6,030,729) or Kim (US 6,576,374, each as discussed above).

The Examiner acknowledges that Okubo et al has a common assignee (Hoya Corporation) with the instant application. The Examiner further acknowledges that, based upon the earlier effective U.S. filing date of the reference, Okubo et al constitutes prior art only under 35 U.S.C. 102(e).” Finally, the Examiner acknowledges that “this rejection under 35 U.S.C. 103(a) might be overcome by: showing that the reference is disqualified under 35 U.S.C. 103(c) as prior art in a rejection under 35 U.S.C. 103(a). See MPEP § 706.02(1)(1) and § 706.02(1)(2).”

Section 103(c) specifies that “Subject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f), and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the claimed invention was made, owned by the same person or subject to an obligation of assignment to the same person.”

Consistent with the provisions of Section 103(c), Applicants, through the undersigned, certify that the subject matter disclosed in the present application and the presently claimed invention, at the time the claimed invention was made, were owned by the same person or subject to an obligation of assignment to the same person owning the patent to Okubo et al.

Withdrawal of the rejection is respectfully requested.

Double Patenting

Claims 1-2 are rejected on the ground of nonstatutory obviousness-type double patenting (ODP) as being unpatentable over claims 1-21 of U.S. Patent No. 7,314,690 [Okubo et al. of Hoya Corporation] in combination with either Yasuzato et al. (US 6,004,699) or Applicant's Admitted Prior Art (AAPA) and either Ito et al. (US 6,030,729) or Kim (US 6,576,374, each as discussed above). This rejection is traversed for at least the following reasons.

First, as to claim 2, the rejection is moot in view of the cancellation of the claim.

Second, as to amended claim 1, Applicants are submitting a Terminal Disclaimer in order to overcome this rejection. By such submission, Applicants do not concede that Okubo has claimed subject matter that in any way raises a double patenting issue, alone or in combination with the prior art referenced by the Examiner. Moreover, Applicants do not concede that the prior art is in anyway relevant, as already noted previously.

Claims 1-2 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting (ODP) as being unpatentable over claims 1-4 of copending Application No. 11/707,131 [Suda of Hoya Corporation, corresponding to US 2007/0190434] in combination with either Yasuzato et al. (US 6,004,699) or Applicant's Admitted Prior Art (AAPA) and either Ito et al. (US 6,030,729) or Kim (US 6,576,374, each as discussed above).

First, as to claim 2, the rejection is moot in view of the cancellation of the claim.

Second, as to amended claim 1, the Examiner admits that the originally pending claims “are not identical,” but asserts that they are not patentably distinct from each other.

Third, the Examiner admits that the *Suda* application claims “do not specifically recite: [4] the use of an additional etching mask (hard mask or etching stop) layer between the light shielding film and the overlying resist film during etching of the light shielding film pattern openings and further etching of the underlying transparent substrate, and removing at least a part of the etching mask pattern or the etching stop layer pattern for manufacturing an auxiliary pattern PSM (*instant claim 1*); or [2] that the light shielding film is etched by a fluorine based etching medium (etchant, *instant claim 2*).”

Fourth, claim 1 has been amended to add detail not found in original claims 1 and 2, and also not claimed in claims 1-4 of Suda. In particular, the claim now includes a step of preparing a photomask blank having the light-shielding film, a thin film for forming an etching mask layer, and a first resist film which are formed in this order on the transparent substrate, where “said light-shielding film comprising a material being etchable by a fluorine-based etching medium, [and] said thin film having a resistance to the fluorine-based etching medium, comprising a metal selected from chromium, tantalum, titanium, aluminum, hafnium, vanadium, or zirconium, an alloy of one or more of said metals, a metal compound containing one or more of oxygen, nitrogen, carbon, fluorine along with one of said metal or alloy,”

Applicants submit that these features, and others recited in claim 1, are not found in the prior art. In particular, the teachings of *Yasuzato et al.*, *AAPA*, *Ito et al.*, and *Kim* do not remedy these deficiencies. as discussed above.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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